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Manufacturing with < 800 MHz Intel® Pentium® III Processors (256K) in the FC-PGA Form Factor

With Reference Design

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- The objective of MAS is:
  - to allow our customers to achieve successful High Volume Manufacturing as rapidly as possible (as opposed to successful design-in)
  - to reduce **C**ustomer **L**ine **F**allout (CLF) equating to higher 1st pass line yields, reduce **C**ustomer **I**nduced **D**amage (CID) returns and reduce **N**o **D**efect **F**ound (NDF) returns.
- This material is not designed to present detailed technical information or specifications, but to share experiences.

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Session Agenda

- Mechanical Features
- Reference Design
- Manufacturing Considerations
- Production Logistics

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Intel® Pentium® III Processor (256K) in the FC-PGA form factor: Overview

- The **F**lip **C**hip **P**in **G**rid **A**rray (FC-PGA) package is a new form factor for the Intel® Pentium® III Processor
  - 370-pin component package for use in desktop applications
  - 256K 8-way set associative integrated level 2 cache memory
  - 0.18 micron process technology
  - Internet Streaming SIMD Extensions (SSE)
  - IA-32 instruction set based on the P6 microarchitecture
  - Utilizes the AGTL+ bus architecture at 100 and 133 MHz
  - For use with the 810E & 820 chipsets
- Same functionality as the Intel® Pentium® III processor in the SECc2 form factor with integrated L2 cache.

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Intel® Pentium® III Processor (256K) in the FC-PGA form factor: Overview

- Uses the same P6 system bus as the Pentium® Pro, Pentium® II and Celeron™ Processors (Some s-specs of the new Pentium® III support a 133MHz bus).
- Uses the PGA370 ZIF socket also used with the Intel® Celeron™ processor in PPGA form factor
- New form factor requires a new thermal reference solution as the FC-PGA has physical and thermal specifications different from those of the PPGA.
- Active heatsink and asymmetric clip are required
  - Existing PPGA heatsink and symmetric attach clip are not mechanically compatible with the FC-PGA.

Hint: NEW asymmetric attach clips may be used with both PPGA and FC-PGA form factors.

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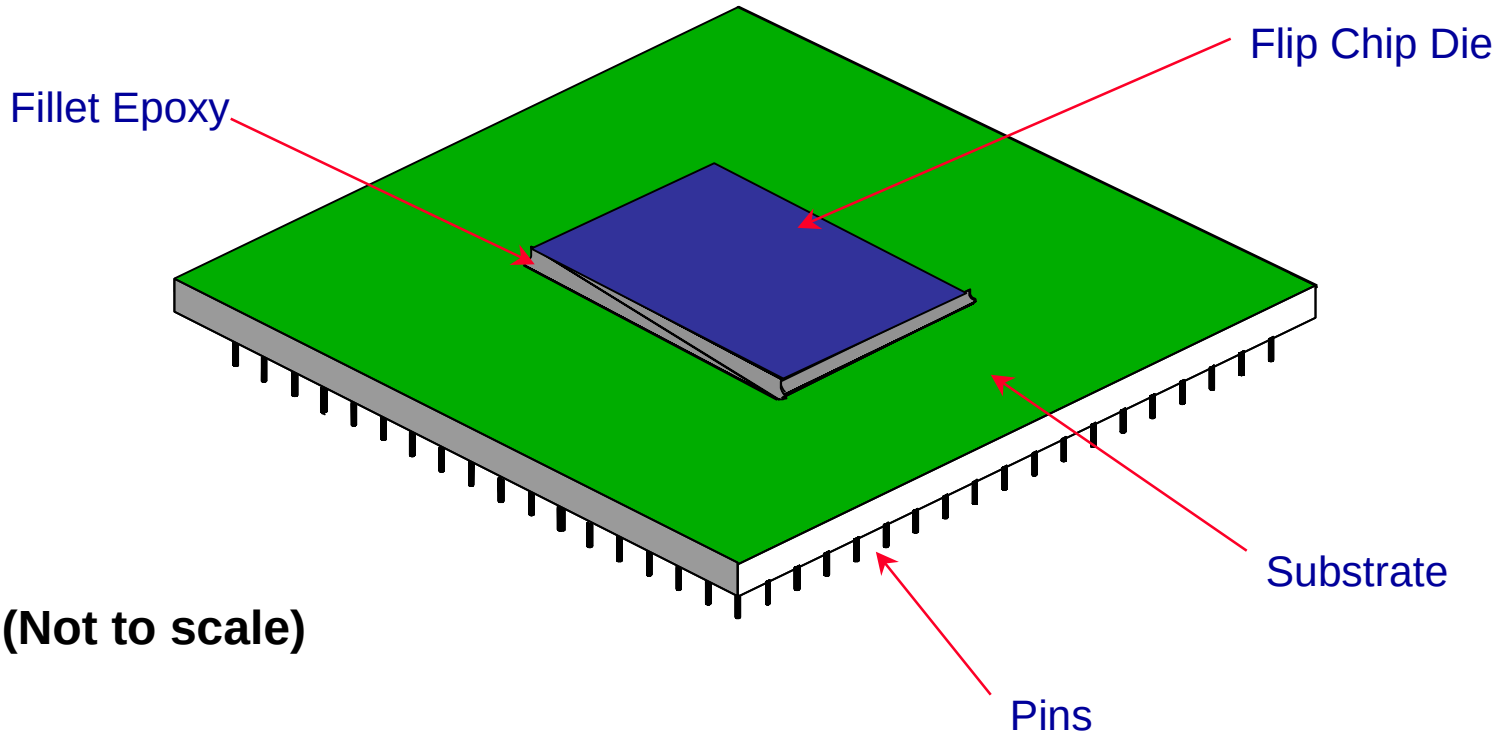
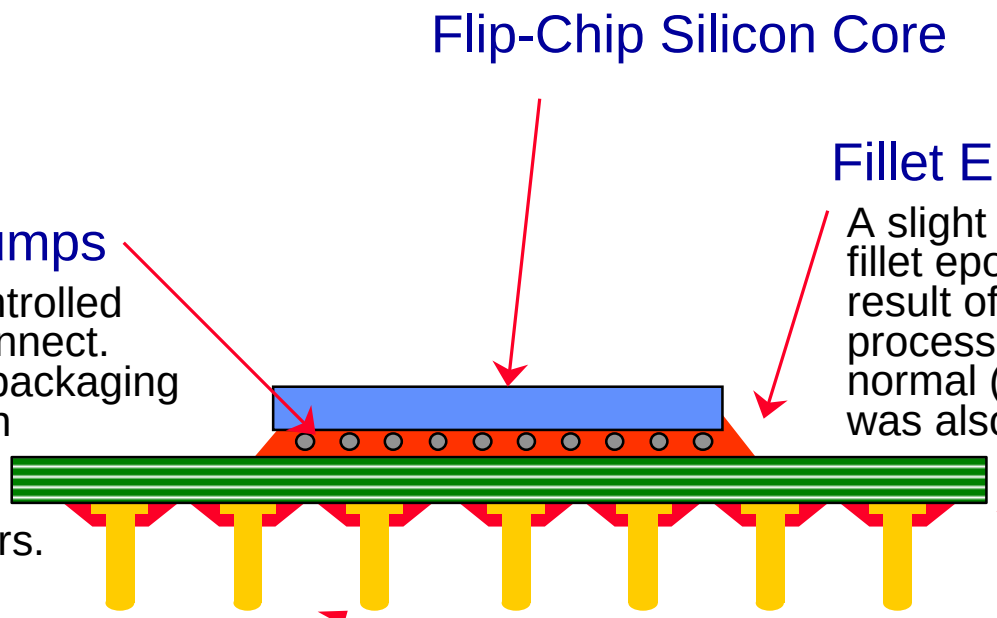
Intel® Pentium® III Processor (256K) in the FC-PGA form factor: Mechanical Features

The FC-PGA package has the processor's silicon die directly mounted to a pinned interposer substrate. The pin grid array is partially populated and there may be surface mount components in the unpopulated central area of the pin field.



(Not to scale)

Intel® Pentium® III Processor in the FC-PGA form factor: Mechanical Features



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Intel Reference Design

Reference Design for the Intel® Pentium® III Processor (256K) in the FC-PGA form factor

Intel has developed a reference design to serve as an enabler for OEM solutions.

- This concept design provides a baseline for OEM thermal solutions.
- Final design, sourcing, and validation of components must be performed by the OEMs.
- Reference designs for other variations of the Pentium® III Processor in the FC-PGA form factor may differ.

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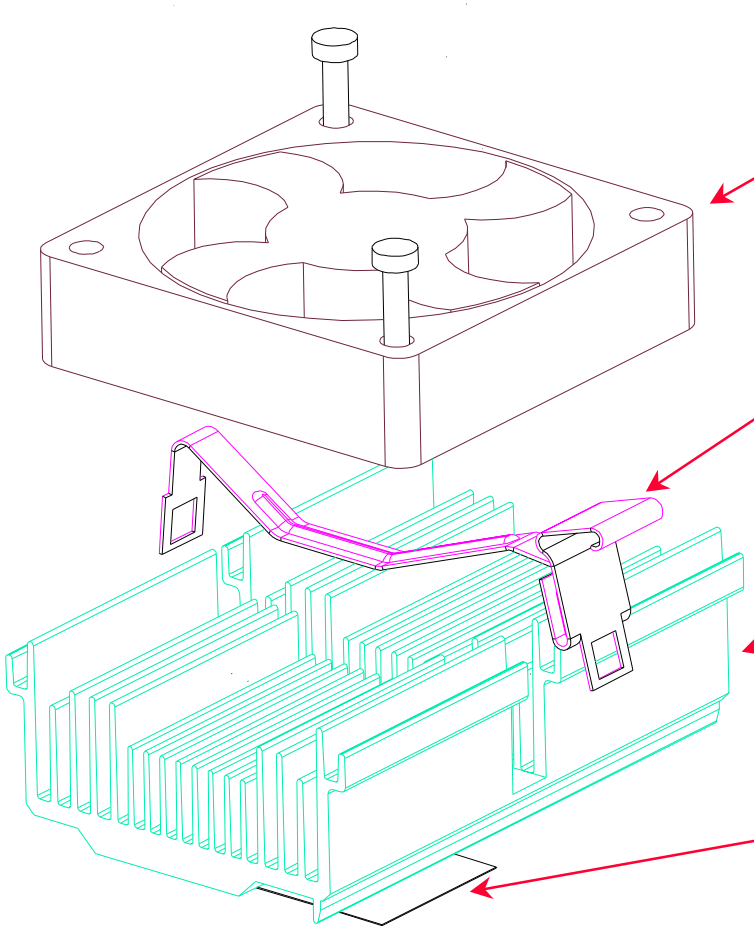
Intel Reference Design

256K Reference Design: Expanded View



Variable Speed Fan

Provides active cooling to meet the required Silicon junction temperature

Asymmetric Heatsink Clip

Placed over heatsink to apply clamping force directly over the exposed CPU core. A metal thumb tab allows for clip attach without the need for a special tool

Extruded Aluminum Heatsink

Placed on top of FC-PGA with thermal interface material in-between.

Thermal Interface Material

Chomerics* XTS454.

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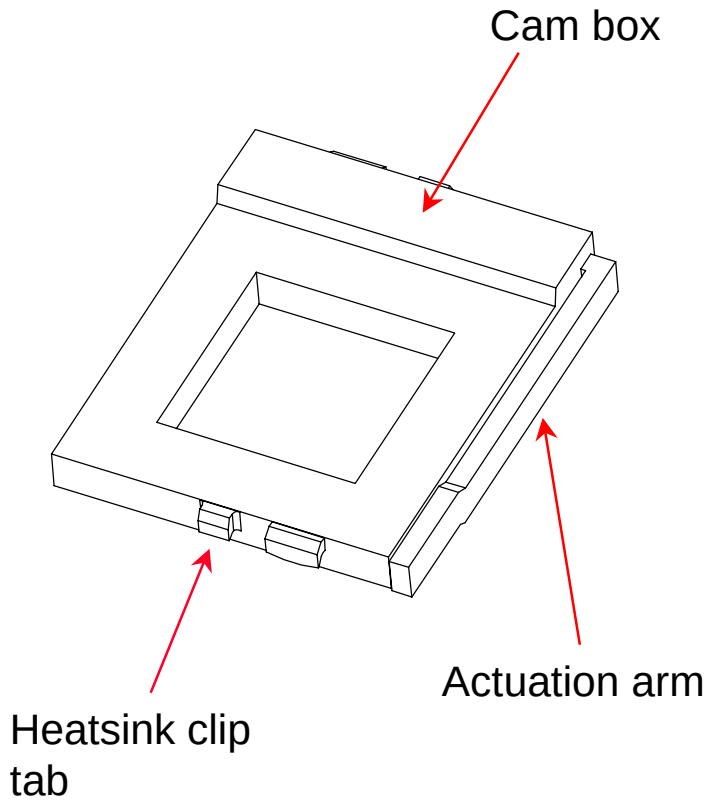
Intel Reference Design

Reference Design: PGA370 ZIF Socket

- ZIF socket design with cam actuation
- Through-hole motherboard mount
- Potential suppliers:
  - Foxconn, AMP
- This is the same socket used with the Intel Celeron™ Processor in the PPGA form factor



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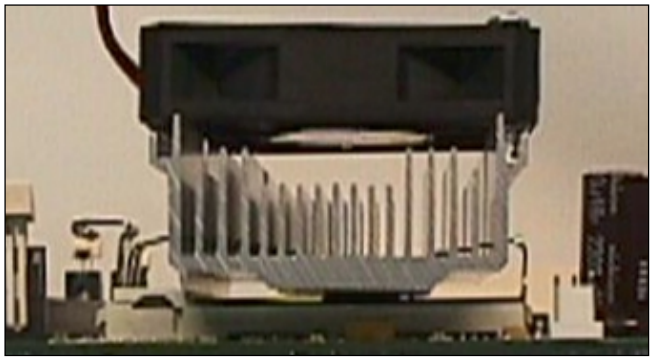
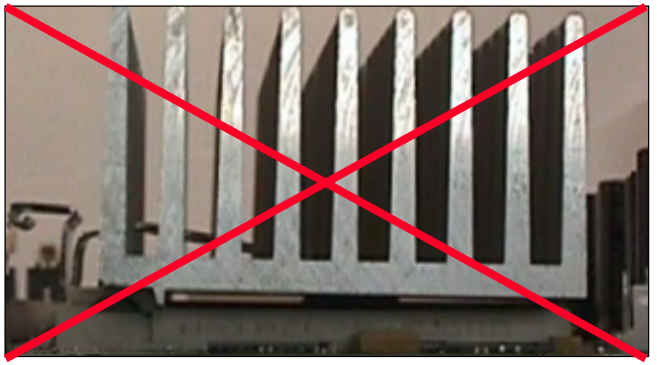
Intel Reference Design

Reference Design: Heatsink

- Intel's reference design thermal solution is an active heatsink; an extruded aluminum heatsink base and a fan attached to the top on the fin array.
- Heatsinks for the PPGA will not work with the FC-PGA. A pedestal is required on the underside of the heatsink to clear the socket cam box.
- **T**hermal **I**nterface **M**aterial (TIM) used with Intel's reference design: Chomerics XTS454.



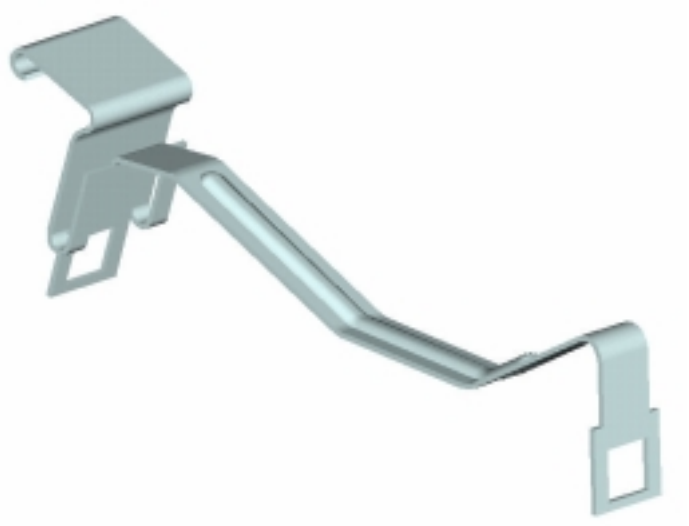
FC-PGA with the reference design heatsink

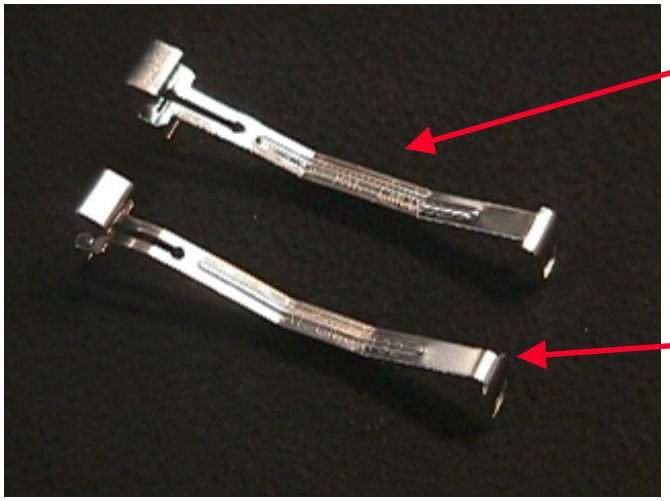


FC-PGA with a PPGA heatsink

Reference Design: Heatsink Attach Clip

An asymmetric heatsink clip is required for the FC-PGA package. An asymmetric clip applies load to the center of the exposed silicon die. A PPGA symmetric clip, which applies load to center of socket body, would place uneven force on the die and tilt the heatsink reducing thermal performance.





Symmetric clip

Clamping force is applied to only one side of the core. **Do Not Use On The FC-PGA.**

Asymmetric clip

Clamping force is applied directly above the core

Clips can potentially be reused, but it's up to the customer to evaluate the number of attempts. This is very much dependent on the customer's ability and control of the process to install and remove the heatsink.

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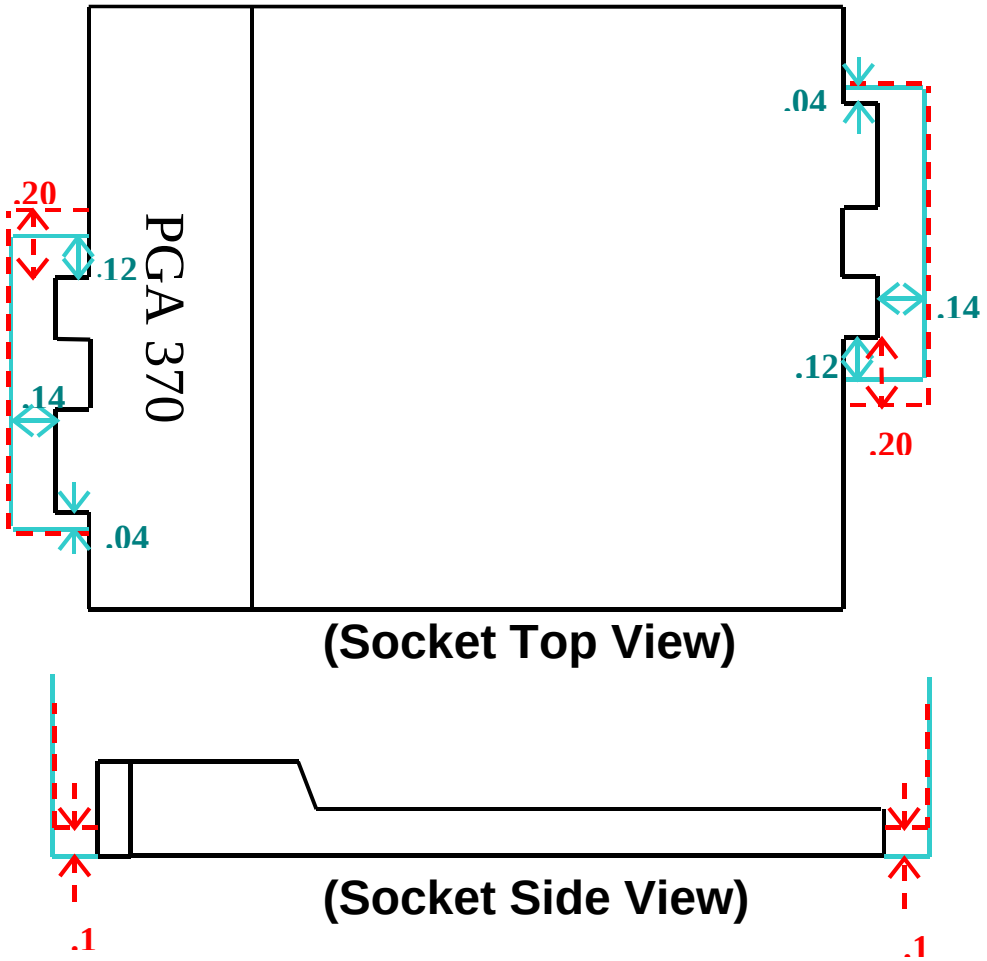
Intel Reference Design

Reference Design: Motherboard Keep-out

- Area around heatsink clip attach hooks must be clear
- Tall components must not interfere with heatsink overhang
- Area near socket actuation arm must be kept clear



Component keep-out zone (at 0.0" height off motherboard)

Component keep-out zone (at 0.1" height off motherboard)

(dimensions are in inches)

There is also a 110 Mil vertical keep-out zone in the center of the socket body.

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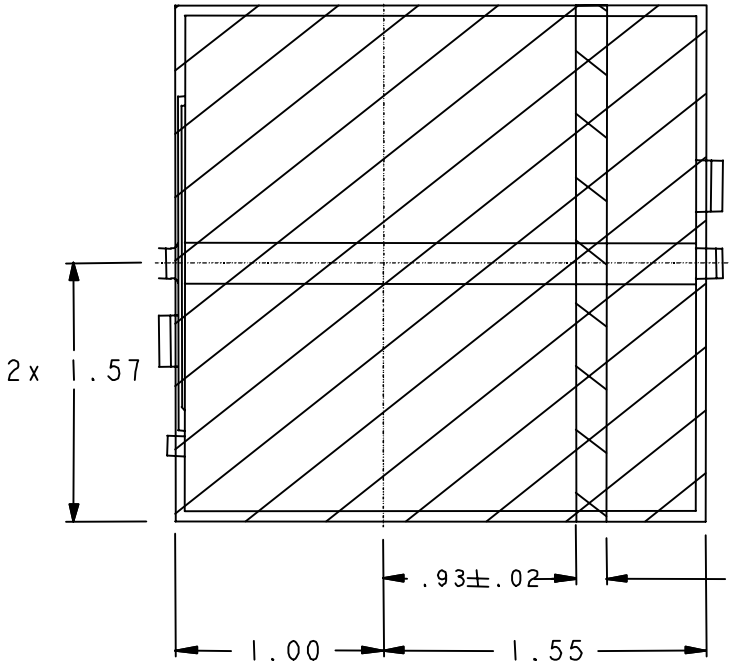
Intel Reference Design

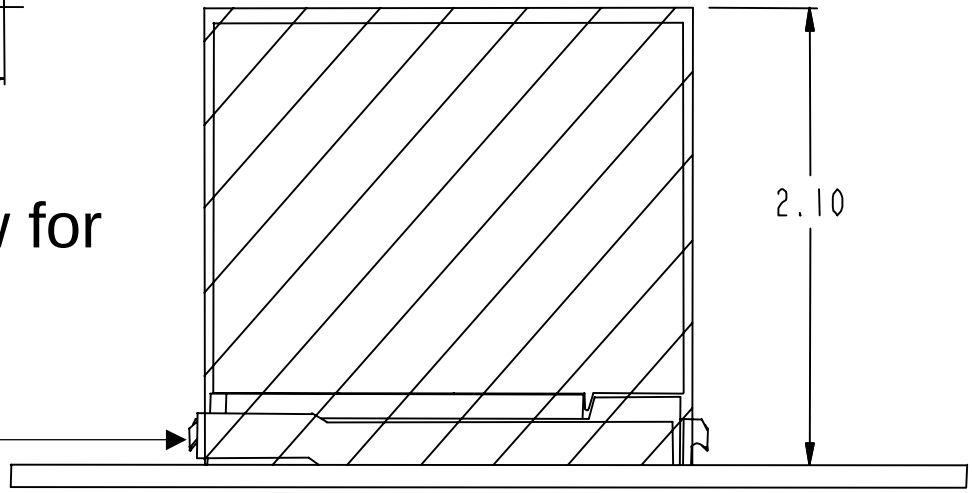
Reference Design: System Keep-out Zones



(Top View)

- Volumetric keep-out allows for adequate ventilation around active heatsink

- Keep-out must allow for heatsink overhang



370 Pin ZIF Socket

(Side View)

(dimensions are in inches)

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Intel Reference Design

Reference Design: Enabling Information

Supplier Reference

Supplier	Socket	Heatsink P/N	Fan	Clip P/N	TIM P/N	Supplier Contact
Aavid (USA) http://www.aavid.com	No	Yes	Yes	No	No	Chris Chapman (603) 223-1728
Cambio (USA)	No	No	No	TS-55001-AA Metal	No	Steve Chugg (603) 524-3714
Chromerics (USA)	No	No	No	No	Chromerics XTS454 Chromerics XT443	John Kefeyan (781) 939-4320 Gary Wood (603) 880-4817
AMP (USA) http://www.amp.com	PGA 370	No	No	No	No	David Bender (717) 592-4347
Foxconn (USA) http://www.foxconn.com	PZ37047-S01-S	No	No	No	No	Julia Jiang (408) 919-6178
Aavid (APAC)	No	P509	Yes	CS01-7 Metal	Chromerics XTS454	Kenny Lin (APAC) kenny@aavid.com.tw
AddA (APAC)	No	AW0512HB-G76B01	Yes	MFC0049950100 VLIF	Chromerics XTS454 Furon C1055	David Chiang (APAC) adda@adda.com.tw
AVC (APAC)	No	FC-2 (112210CTH01)	Yes	50209013 Metal	Chromerics XTS454 Chromerics XT443	Alex Lin (APAC) alex@avc.com.tw

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Manufacturing Considerations: Handling

Careful handling is required for the FC-PGA

- Effects of damage may not always be immediately apparent.
- Material should be kept in ESD protective trays until it is ready for use.
- Units should be handled by the substrate edge using lint free gloves.
- Any units dropped during handling should be scrapped.
- Attempts to physically remove contamination induced by poor handling and storage practices could compromise reliability. However, pressurized air can be used to blow off loose particles.

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Manufacturing Considerations: Handling

Use care with the exposed processor silicon die

- Avoid touching or putting excessive force on the die.
  - 20 lbf maximum static loading on the die surface
  - 200 lbf maximum transient loading on the die surface (i.e. during OEM heatsink attach.
  - 100 lbf maximum transient loading on the die edge (i.e. during OEM heatsink attach/removal.

Static loading is the applied force on the package/die throughout the entire life cycle of field use and corresponds to the clip force design plus the total weight of heatsink.

Dynamic or transient loading only occurs in a few specific occasions (shipping / handling, etc.) and the intent is not to apply these higher forces on the package/die throughout the entire life cycle.

Intel's reference design clip will give the correct load force required to meet static loading and to insure the desired bond line thickness of the thermal interface material (TIM)

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Manufacturing Considerations: Handling

- Avoid introducing foreign material onto die surface. Thermal interface material performance may be impeded and large particles may damage the die when attaching the thermal solution.
- The exposed silicon die typically appears blue or silver in color. Other colors may appear from lot to lot, but are not adverse to the part and are considered normal to Intel's manufacturing process.

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MA Manufacturing Considerations: ESD Sensitivity

Processors should only be unpacked from boxes at ESD workstations

- All persons handling processors should be properly grounded.
- All work and storage surfaced for processors should be properly grounded.
- All tools and test equipment used to install or rework processors should be properly grounded.

Use proper storage and material transfer

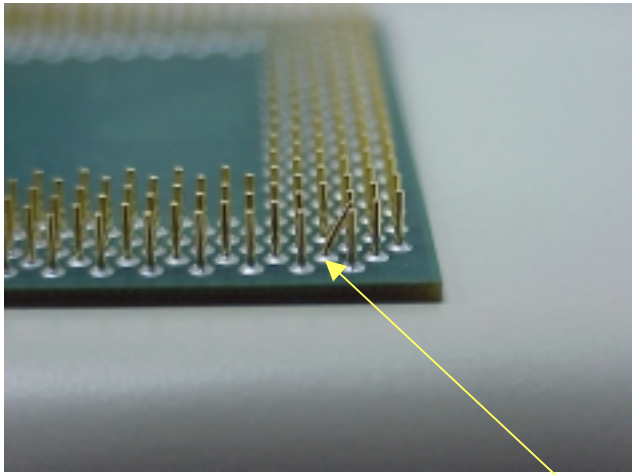
- Transfer material using ESD safe trays, not by hand
- Only remove material from trays when it is ready to be used
- Units should be handled by the substrate edge using lint free gloves

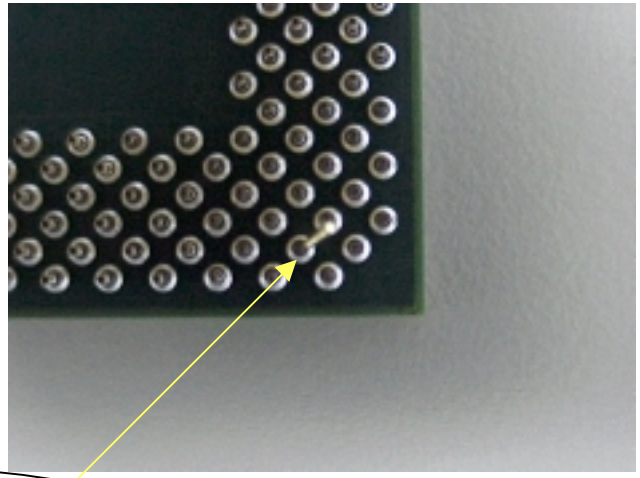
For more information on ESD, visit Intel's website at: **http://developer.intel.com/design/quality/eosesd/index.htm**

Manufacturing Considerations: Visual Inspection and Pin Rework

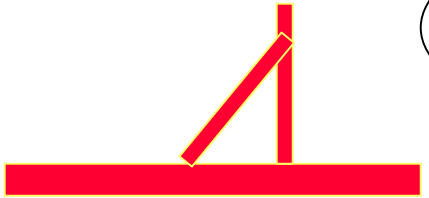
Before installing the processor, inspect the package for:

- Debris on the die or within the pins which cannot be blown off
- Bent or misaligned pins

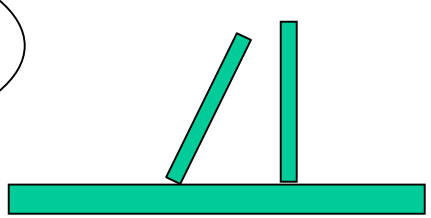




Reject and scrap any unit that has bent pin(s) that cross an adjacent pin (> 45 degrees). Pins that are bent ≤ 45 degrees are reworkable.



Bent pin > 45 degrees
Reject and Scrap



Bent pin ≤ 45 degrees
Reworkable

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Manufacturing Considerations: Visual Inspection and Pin Rework

- If a large number of units require rework and no in-house capability exists for lead conditioning:
  - Use of an outside service that has automated lead conditioning capabilities could be subcontracted.
  - Purchase lead conditioning equipment for in-house capability.

    Precision Technology Inc. - Santa Clara, Ca.
    Model IC2000

  - Manual lead straightening tools can be acquired at:

    NAPCO Tool - Tempe, Az.

  - In a bind, on a limited basis, it has been found that a mechanical pencil (0.5 – 0.9 mm) will also work.

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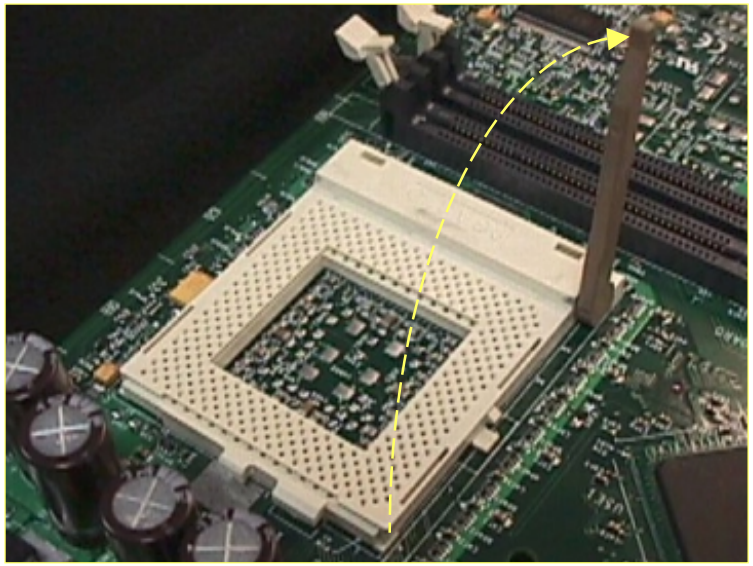
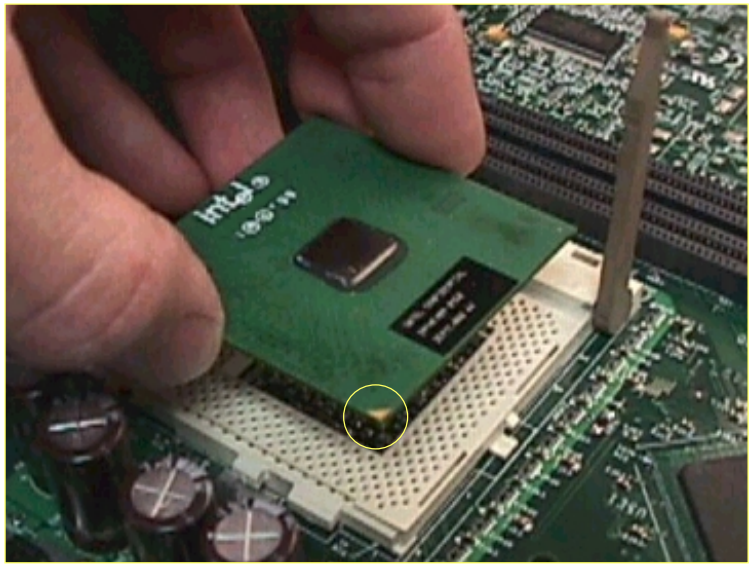
Manufacturing Considerations: CPU Insertion

Reference Design Example





Step 1

Open the socket by raising the actuation lever. Ensure the socket is free of debris and the socket holes are clear of any contamination

Step 2

Insert the processor.

Verify proper pin 1 orientation by aligning the FC-PGA corner marking with the socket corner closest to the actuation arm tip. The pin field is keyed to prevent mis-oriented insertion.

Don’t force processor into socket. If it does not go in easily, check for mis-orientation and debris.

Make sure the processor is fully inserted into the socket on all sides.

OEMs are responsible for validating the design they choose.

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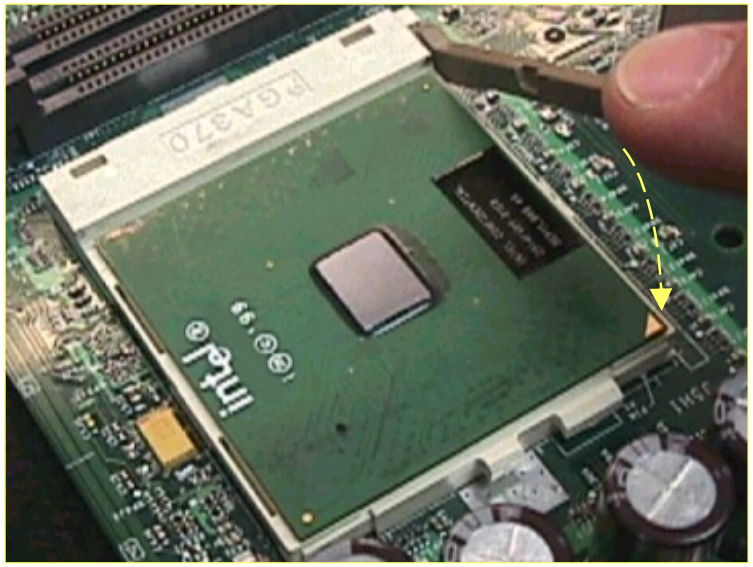
Manufacturing Considerations: CPU Insertion

Reference Design Example



Step 3

Close the socket by lowering and locking the actuation lever.

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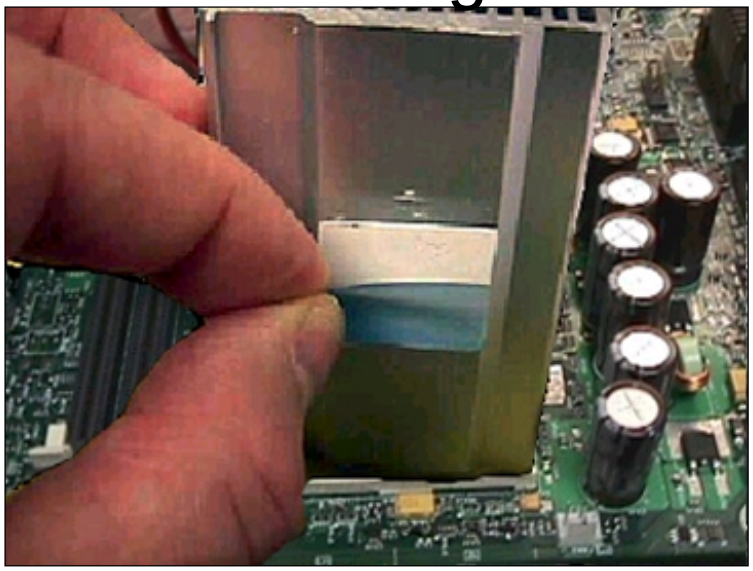
OEMs are responsible for validating the design they choose.

Manufacturing Considerations: Heatsink Attach

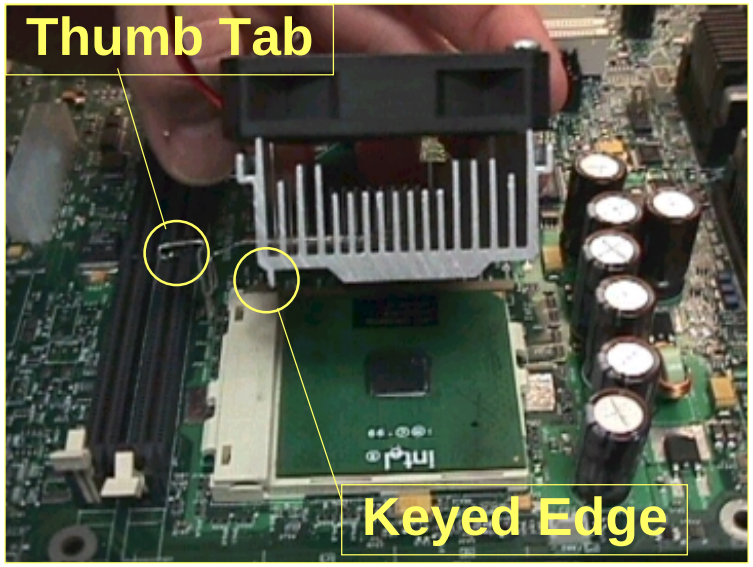
Reference Design Example



Step 1

Remove the protective liner from the thermal interface material on the underside of the heatsink.

This liner is not normally present on the Intel reference active heatsink.



Step 2

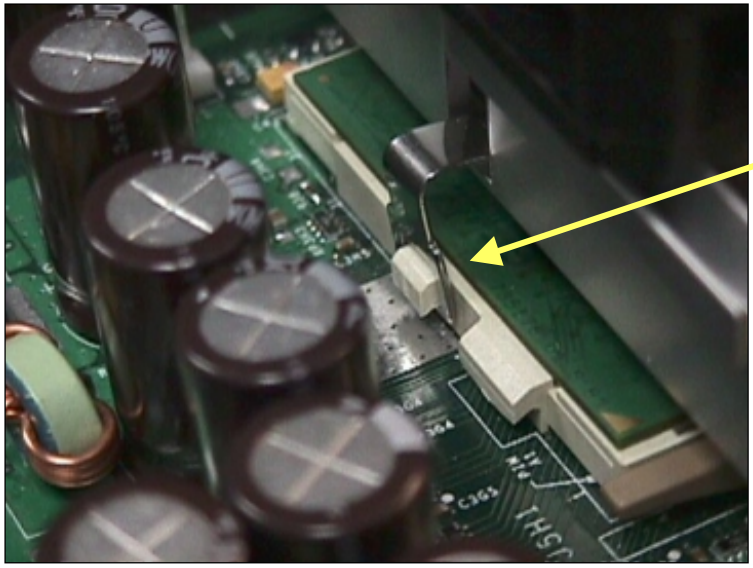
Orient the heatsink with the keyed edge of heatsink along the cam box side of the processor.

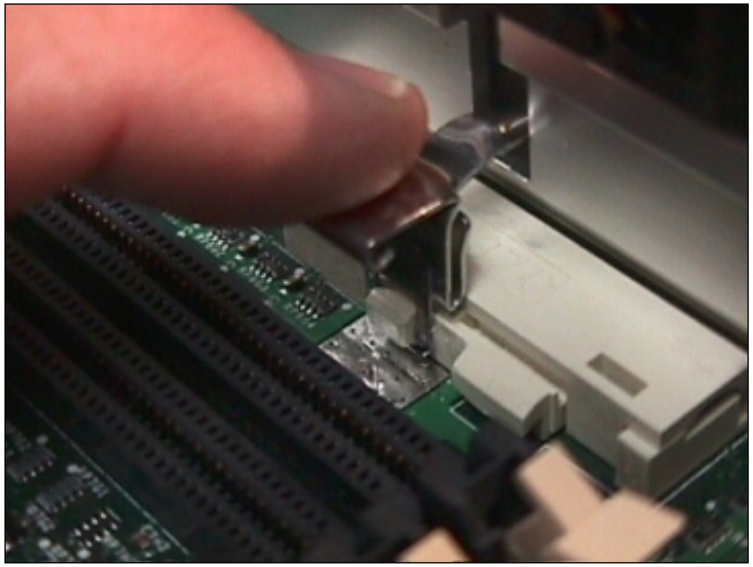
The clip should be oriented so that the thumb tab will engage on the cam box side of the socket.

OEMs are responsible for validating the reference design they choose. The heatsink attach process may differ depending on the design used.

Manufacturing Considerations: Heatsink Attach

Reference Design Example





Step 3

Seat the heatsink onto the processor and engage the clip opposite from the cam box onto its socket tab first.

CAUTION: Do not slide the heatsink once it is attached to the processor as the thermal interface material will tear. Instead lift the heatsink off, by pulling straight in the Z-axis until the heatsink separates. Reseat it back down onto the processor, if required, for proper alignment.

Step 4

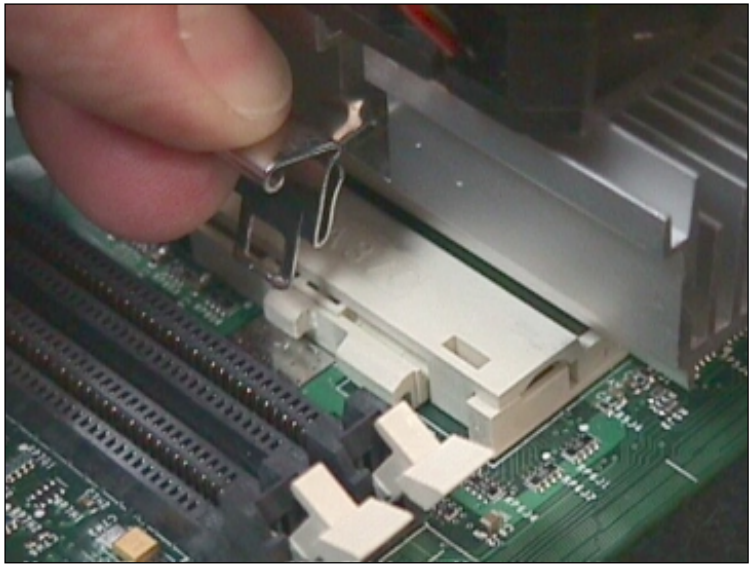
Engage the thumb tab side of the clip onto the cam box socket tab second.

Connect the fan cable to the appropriate header on the motherboard.

OEMs are responsible for validating the reference design they choose. The heatsink attach process may differ depending on the design used.

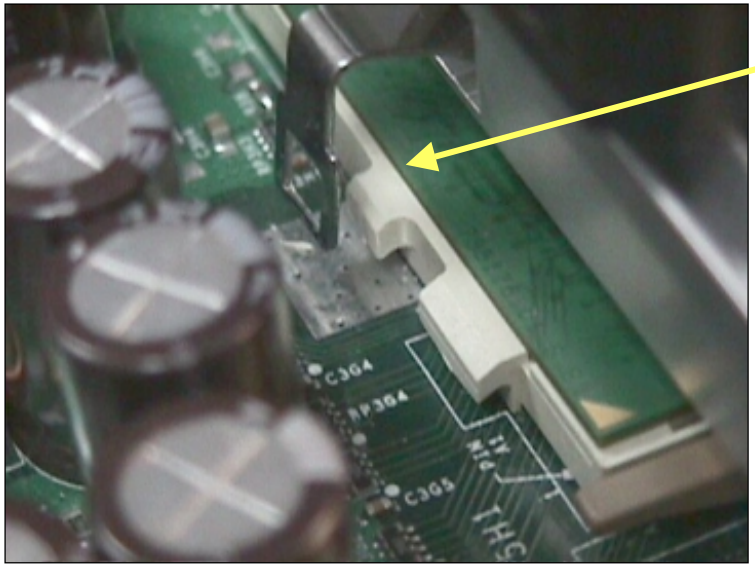
Manufacturing Considerations: Heatsink Removal

Reference Design Example



Step 1

Disengage the clip from socket on the cam box side first by pressing down and rotating the thumb lever.



Step 2

Unhook the clip from the other side of the socket.

OEMs are responsible for validating the reference design they choose. The heatsink removal process may differ depending on the design used.

Manufacturing Considerations: Heatsink Removal

Reference Design Example

Step 3

Gently lift the heatsink off of the processor. Depending on the thermal interface used, this could require a slight amount of force.

Clean any residual thermal interface material from the exposed silicon core before attaching another heatsink.

Removed heatsinks must have their thermal interface material replaced before they are attached to another processor.

OEMs are responsible for validating the reference design they choose. The heatsink removal process may differ depending on the design used.

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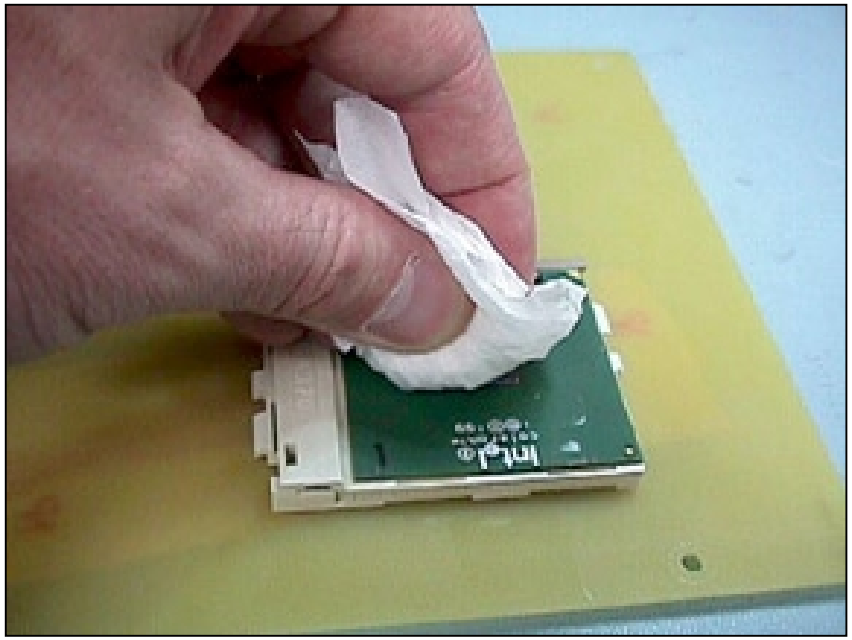
Manufacturing Considerations: TIM Removal

Reference Design Example

To Remove Thermal Interface Material (TIM) From The Die:



- Gently wipe the remaining TIM residue from die with electronic grade isopropyl alcohol and disposable lint free wipes (i.e. chem-wipes).

  Hint: this is much easier if the heatsink is allowed to cool before disassembly

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OEMs are responsible for validating the reference design they choose. The thermal interface material removal process may differ. Chomerics XTS454 was used for this demonstration.

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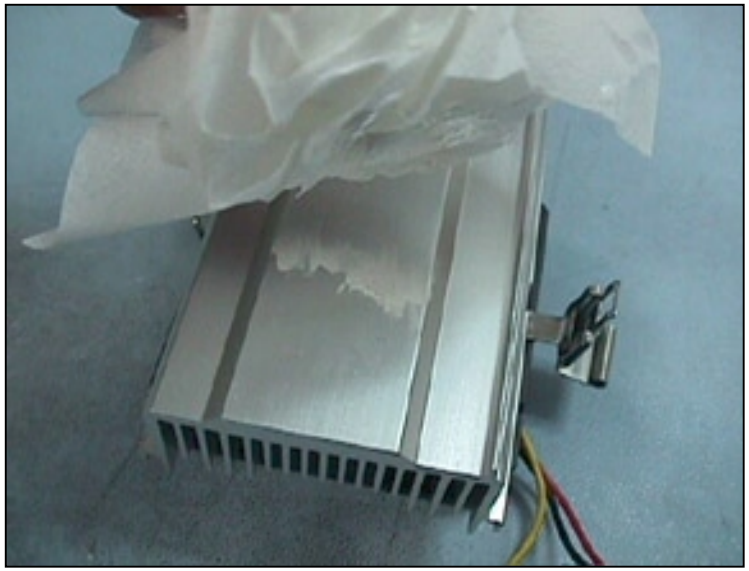
Manufacturing Considerations: TIM Removal

Reference Design Example



- Removal Of Thermal Interface Material From The Heatsink
- Warm the heatsink with a heat gun until the thermal interface material starts to become soft (up to 50°C should be adequate).
- Gently wipe the TIM residue from the heatsink with electronic grade isopropyl alcohol and disposable lint free wipes (i.e. chem-wipes).

OEMs are responsible for validating the reference design they choose. The thermal interface material removal process may differ. Chomerics XTS454 was used for this demonstration.

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Manufacturing Considerations: TIM Removal

Reference Design Example

Heat Gun Not Available:

- If a heat gun is not available, scrape the thermal interface material off with a plastic scraper.
- Clean the remaining residue from the heatsink with electronic grade isopropyl alcohol and disposable lint free wipes (i.e. chem-wipes).

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OEMs are responsible for validating the reference design they choose. The thermal interface material removal process may differ. Chomerics XTS454 was used for this demonstration.

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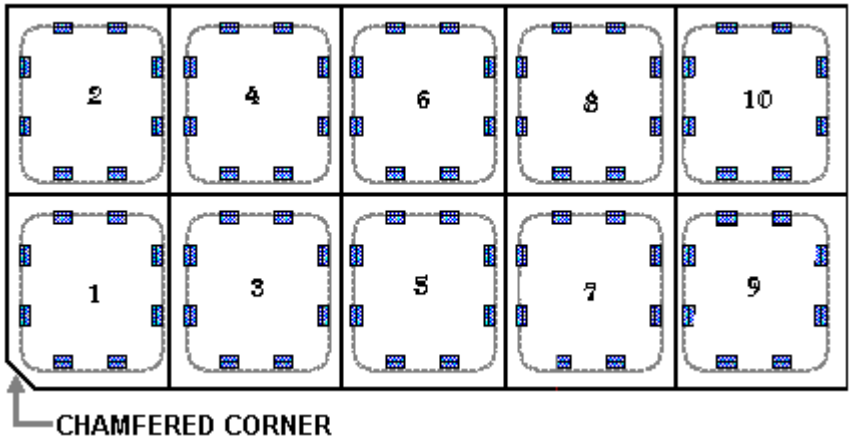
Production Logistics: Shipping Media

- The FC-PGA uses the same shipping media type as the PPGA.
- Standard JEDEC thin low-temp tray
  - 60°C max temp
  - Number of units per tray = 10
  - Number of trays per box = 10
  - Weight of empty box = 248.4 grams
  - Weight of full box = 1.84 Kg
  - Maximum height for empty box stacking = 14 boxes
  - Maximum height for full box stacking = 2 boxes



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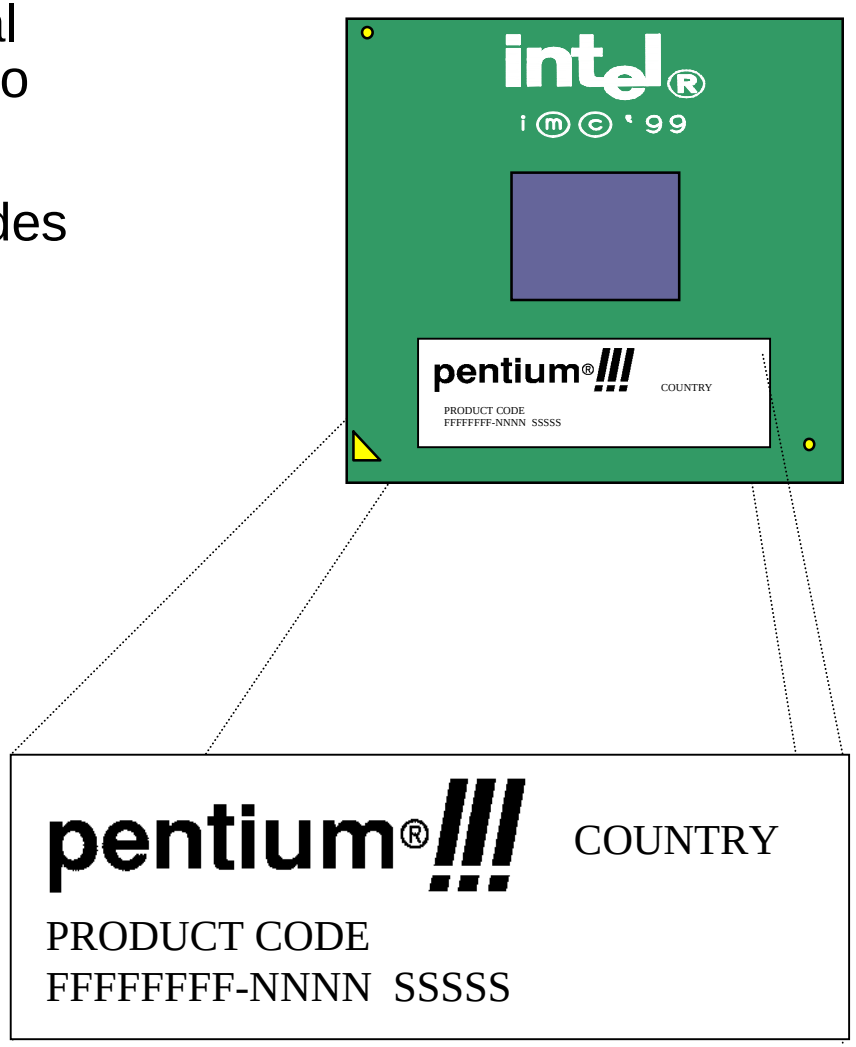
Production Logistics: Processor Marking

- Intel logo marking and legal markings silk-screened onto substrate
- Dynamic Laser Mark Includes
  - Product logo
  - Product code (includes speed and cache size)
  - Country of origin
  - FFFFFFFF = FPO #
  - NNNN = Serial #
  - SSSSS = S-Spec #



Dynamic Laser Mark